TP-106-08
March 31, 1993

U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

LABORATORY TEST PROCEDURE

FOR

FMVSS 106

Brake Hoses

SAFETY ASSURANCE
Office of Vehicle Safety Compliance
Room 6115, NSA-30
400 Seventh Street, SW
Washington, DC 20590

OVSC LABORATORY TEST PROCEDURE NO. 106
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1. PURPOSE AND APPLICATION

The Office of Vehicle Safety Compliance (OVSC) provides contracted laboratories with Laboratory Test Procedures (TPs) which serve as guidelines for obtaining compliance test data. The data are used to determine if a specific vehicle or item of motor vehicle equipment meets the minimum performance requirements of the subject Federal Motor Vehicle Safety Standard (FMVSS). The purpose of the OVSC Laboratory Test Procedures is to present a uniform testing and data recording format, and provide suggestions for the use of specific equipment and procedures. Any contractor interpreting any part of an OVSC Laboratory Test Procedure to be in conflict with a Federal Motor Vehicle Safety Standard or observing any deficiencies in a Laboratory Test Procedure is required to advise the Contracting Officer's Technical Representative (COTR) and resolve the discrepancy prior to the start of compliance testing.

Contractors are required to submit a detailed test procedure to the COTR before initiating the compliance test program. The procedure must include a step-by-step description of the methodology to be used.

The OVSC Laboratory Test Procedures are not intended to limit or restrain a contractor from developing or utilizing any testing techniques or equipment which will assist in procuring the required compliance test data.

NOTE:

The OVSC Laboratory Test Procedures, prepared for use by independent laboratories under contract to conduct compliance tests for the OVSC, are not intended to limit the requirements of the applicable FMVSS(s). In some cases, the OVSC Laboratory Test Procedures do not include all of the various FMVSS minimum performance requirements. Sometimes, recognizing applicable test tolerances, the Test Procedures specify test conditions which are less severe than the minimum requirements of the standards themselves. Therefore, compliance of a vehicle or item of motor vehicle equipment is not necessarily guaranteed if the manufacturer limits certification tests to those described in the OVSC Laboratory Test Procedures.

2. GENERAL REQUIREMENTS

FMVSS 106 specifies labeling and performance requirements for motor vehicle brake hose, brake hose assemblies, and brake hose end fittings.

The purpose of S106 is to reduce deaths and injuries occurring as a result of brake system failure from pressure or vacuum loss due to hose or hose assembly rupture. The requirements apply to passenger cars, multipurpose passenger vehicles, trucks, buses, trailers, and motorcycles, and to hydraulic, air and vacuum brake hose, brake hose assemblies, and brake hose end fittings for use in those vehicles.

The test procedures and methods outlined herein are based upon the requirements of S106 effective on 9/1/74 for brake hose and end fittings, 3/1/75 for brake hose assemblies, and 9/1/75 for vehicles.

3. SECURITY

The contractor shall provide appropriate security measures to protect the OVSC test specimens from unauthorized personnel during the entire compliance testing program. The contractor is financially responsible for any acts of theft and/or vandalism which occur during the storage of test specimens. Any security problems which arise shall be reported by telephone to the Industrial Property Manager (IPM), Office of Contracts and Procurement, within two working days after the incident. A letter containing specific details of the security problem will be sent to the IPM (with copy to the COTR) within 48 hours.

The contractor shall protect and segregate the data that evolves from compliance testing before and after each test. No information concerning the compliance testing program shall be released to anyone except the COTR, unless specifically authorized by the COTR, the COTR's Branch or Division Chief or by the Contracting Officer.

NO INDIVIDUALS, OTHER THAN CONTRACTOR PERSONNEL, SHALL BE ALLOWED TO WITNESS ANY COMPLIANCE TEST UNLESS SPECIFICALLY AUTHORIZED BY THE COTR.

4. GOOD HOUSEKEEPING

Contractors shall maintain the entire compliance testing area, test fixtures and instrumentation in a neat and clean condition with test instruments arranged in an orderly manner consistent with good test laboratory housekeeping practices.

5. TEST SCHEDULING AND MONITORING

The contractor shall submit a test schedule to the COTR prior to testing. Tests shall be completed as required in the contract. All testing shall be coordinated with the COTR to allow monitoring by the COTR or other OVSC personnel.

6. TEST DATA DISPOSITION

The contractor shall make all preliminary compliance test data available to the COTR within four hours after the test. Final test data, including digital printouts and computer generated plots (if applicable), shall be furnished to the COTR in accordance with the contract schedule. Additionally, the contractor shall analyze the preliminary test results as directed by the COTR.

All backup data sheets, strip charts, recordings, plots, technicians notes, etc., shall be retained by the contractor for a minimum of 3 years after conclusion of each delivery order, purchase order, etc. The COTR shall direct final disposition at that time.

7. GOVERNMENT FURNISHED PROPERTY (GFP) AND TEST SAMPLES

TEST SAMPLE IDENTIFICATION AND STORAGE

A test set of brake hoses shall consist of a quantity of test hoses plus a specific quantity which may be required for retest if necessary. The quantities shown below shall be used for tests unless amended by the contract.

HOSE TYPE	NO. OF TEST HOSES
Hydraulic	19
Air	14
Vacuum	10

Each hose shall be banded on one end or tagged at one end, and marked with a laboratory group number and individual sample number such as "001-2" for group 1, specimen number 2. The marking shall be suitable to withstand all tests and handling environments. Test flow and usage of the hose assemblies shall be as shown in Figures 1, 2, 3 and 4.

An inventory shall be made of the number, name and condition of samples received, and then the samples shall be stored in a dry, clean, dark, and dust free area to prevent damage to them in any manner which may affect test results.

7. GFP AND TEST SAMPLES….Continued

FLOW SEQUENCE FOR BRAKE HOSE COMPLIANCE TESTS

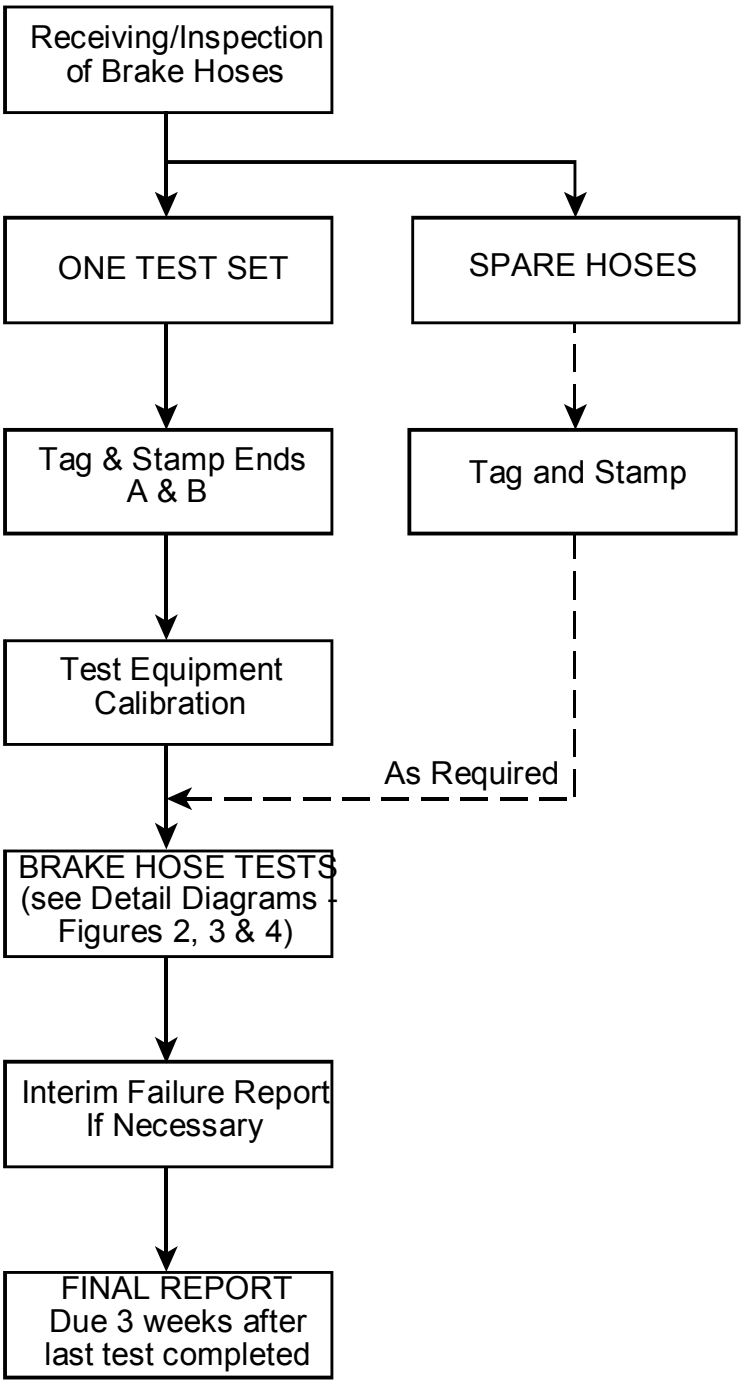

FIGURE 1

7. GFP AND TEST SAMPLES....Continued

FLOW SEQUENCE FOR HYDRAULIC BRAKE HOSES

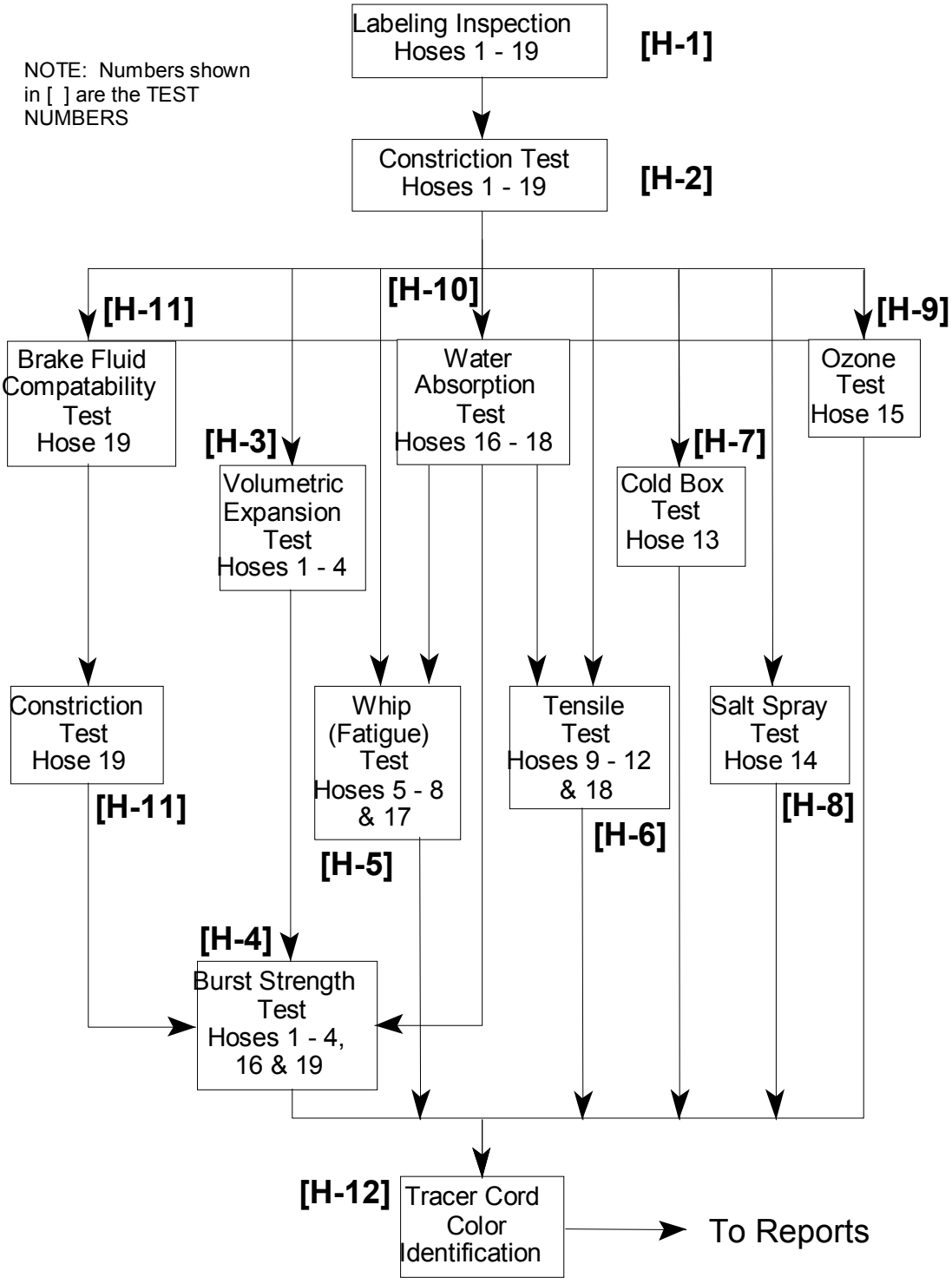

FIGURE 2

FLOW SEQUENCE FOR AIR BRAKE HOSES

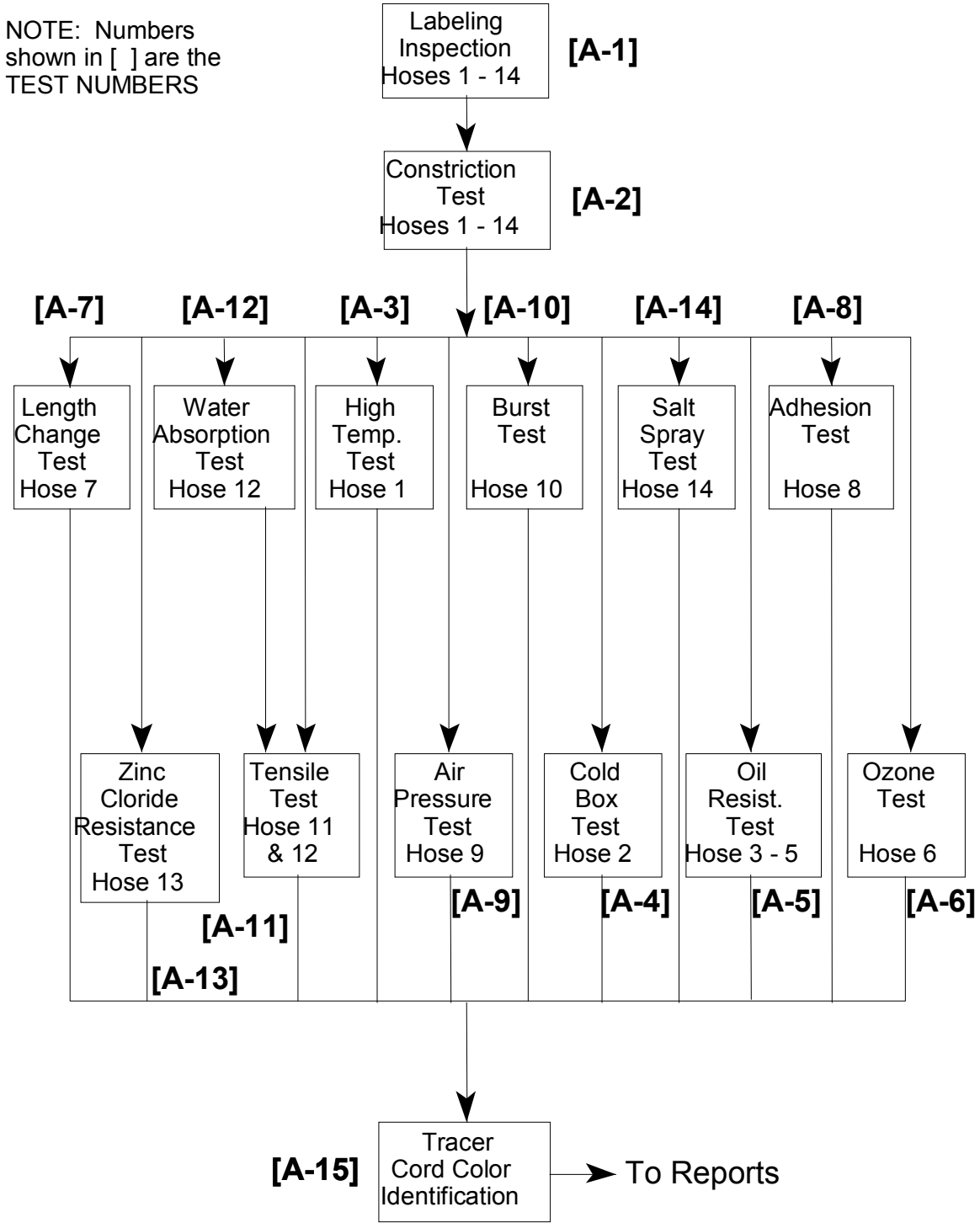

FIGURE 3

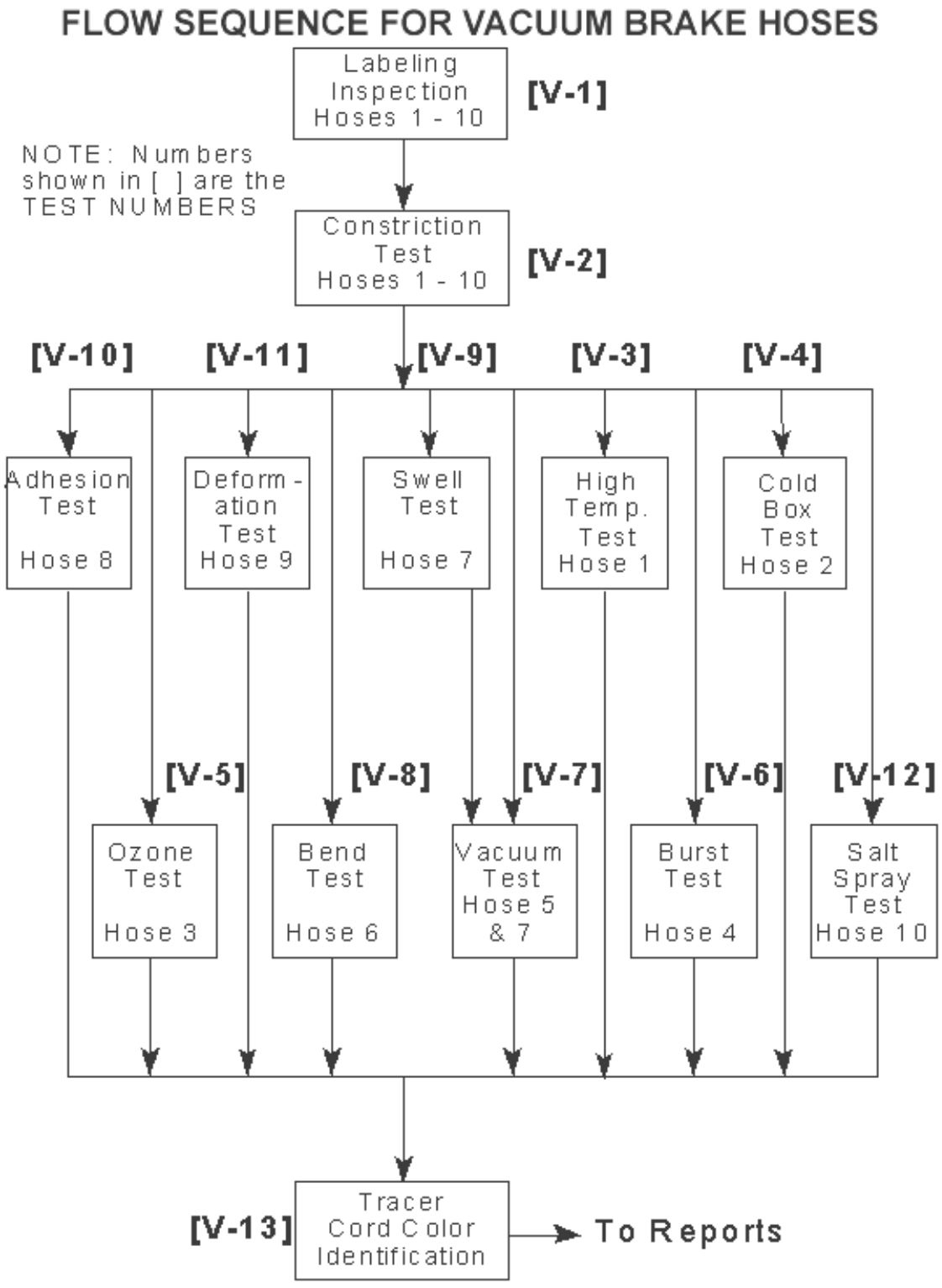
FLOW SEQUENCE FOR VACUUM BRAKE HOSES
Labeling Inspection Hoses 1 - 10
[V-1]
NOTE: Numbers shown in [ ] are the TEST NUMBERS
Constriction Test Hoses 1 - 10
[V-2]
[V-10]
[V-11]
[V-9]
[V-3]
[V-4]
Adhesion Test Hose 8
Deform - ation Test Hose 9
Swell Test Hose 7
High Temp. Test Hose 1
Cold Box Test Hose 2
[V-5]
[V-8]
[V-7]
[V-6]
[V-12]
Ozone Test Hose 3
Bend Test Hose 6
Vacuum Test Hose 5 & 7
Burst Test Hose 4
Salt Spray Test Hose 10
[V-13]
Tracer Cord Color Identification
To Reports

FIGURE 4

8. CALIBRATION OF TEST INSTRUMENTS

Before the contractor initiates the safety compliance test program, a test instrumentation calibration system will be implemented and maintained in accordance with established calibration practices. Guidelines for setting up and maintaining such calibration systems are described in MIL-C-45662A, "Calibration System Requirements". The calibration system shall be set up and maintained as follows:

A. Standards for calibrating the measuring and test equipment will be stored and used under appropriate environmental conditions to assure their accuracy and stability.

B. All measuring instruments and standards shall be calibrated by the contractor, or a commercial facility, against a higher order standard at periodic intervals NOT TO EXCEED TWELVE (12) MONTHS except for static types of measuring devices such as rulers, weights, etc., which shall be calibrated at periodic intervals not to exceed two years. Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.

C. All measuring and test equipment and measuring standards will be labeled with the following information:

(1) Date of calibration
(2) Date of next scheduled calibration

D. A written calibration procedure shall be provided by the contractor which includes as a minimum the following information for all measurement and test equipment unless the calibration is performed by a licensed commercial facility.

(1) Type of equipment, manufacturer, model number, etc.
(2) Measurement range
(3) Accuracy
(4) Calibration interval
(5) Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident)

E. Records of calibration for all test instrumentation shall be kept by the contractor in a manner which assures the maintenance of established calibration schedules. All such records shall be readily available for inspection when requested by the COTR. The calibration system will need the acceptance of the COTR before the test program commences. The records of instrumentation used in a specific test are to be included in Appendix B of the Final Report.

9. PHOTOGRAPHIC DOCUMENTATION

Each final test report shall include glossy photographs (minimum size 4 x 6 inches) of the test setup used for the setup for each phase of testing. One set of original photographs shall be included in the final test report which will be used for optical scanning by the OVSC. Other copies of the final test report may contain multilith copies of the original photographs. Include all photographs in Appendix C of the final report. Except for unusual hose assemblies, a standard typical photograph for each test may be used.

Include photos of test equipment and instrumentation used in conducting the following tests:

HYDRAULIC BRAKE HOSES -
(01) Volumetric Expansion Test
(02) Bursting Strength Test
(03) Whip Machine - Side View
(04) Whip Machine - End View
(05) Tensile Test Machine
(06) Interior of Cold Box with wood mandrel
(07) Salt Spray Cabinet
(08) Ozone Cabinet
(09) Water Absorption Setup
(10) Brake Fluid Compatibility Oven (Interior)

AIR BRAKE HOSES -
(01) High Temperature Test (Interior)
(02) Cold Box (Interior)
(03) Oil Resistance Test
(04) Ozone Cabinet
(05) Length Change Test
(06) Adhesion Test
(07) Air Pressure Test
(08) Burst Strength Test
(09) Tension Test
(10) Water Absorption Setup
(11) Salt Spray Cabinet

VACUUM BRAKE HOSES -
(01) High Temperature Test (Interior)
(02) Cold Box (Interior)
(03) Ozone Cabinet
(04) Burst Strength Test
(05) Vacuum Test
(06) Bend Test
(07) Adhesion Test
(08) Deformation Test
(09) Salt Spray Cabinet

Failed sample photographs shall be provided if the failure effect is visible. These photographs shall show the point of failure from each point of view that can add significant detail.

10. DEFINITIONS

ARMOR

Protective material installed on a brake hose to increase the resistance of the hose or hose assembly to abrasion or impact damage.

BRAKE HOSE

A flexible conduit, other than a vacuum tubing connector, manufactured for use in a brake system to transmit or contain the fluid pressure or vacuum used to apply force to a vehicle's brakes.

BRAKE HOSE ASSEMBLY

A brake hose, with or without armor, equipped with end fittings for use in a brake system, but does not include an air or vacuum assembly prepared by the owner or operator of a used vehicle, by his employee, or by a repair facility, for installation in that used vehicle.

BRAKE HOSE END FITTING

A coupler other than a clamp, designed for attachment to the end of a brake hose.

DIMENSIONAL DESCRIPTIONS

For hose, a dimensional description such as "1/4-inch hose" refers to the Nominal Inside Diameter (I.D.).

For tubing, a dimensional description such as "1/4-inch tubing" refers to the Nominal Outside Diameter (O.D.).

FREE LENGTH

The linear measurement of hose exposed between the end fittings of a hose assembly in a straight position.

PERMANENTLY ATTACHED END FITTING

An end fitting that is attached by deformation of the fitting about the hose by crimping or swaging, or an end fitting that is attached by use of a sacrificial sleeve or ferrule that requires replacement each time a hose assembly is rebuilt.

RUPTURE

Any failure that results in separation of a brake hose from its end fitting or in leakage.

10. DEFINITIONS….Continued

VACUUM TUBING CONNECTOR

A flexible conduit of vacuum that –

- Connects metal tubing to metal tubing in a brake system
- Is attached without end fittings
- When installed, has an unsupported length less than the total length of those portions that cover the metal tubing

11. PRETEST REQUIREMENTS

IN-HOUSE TEST PROCEDURE

Prior to conducting any compliance test, contractors are required to submit a detailed in-house compliance test procedure to the COTR which includes a step-by-step description of the methodology to be used. Written approval must be obtained from the COTR before initiating the compliance test program so that all parties are in agreement.

The test methods and procedures shall be based on the requirements of the following non-NHTSA documents wherein S106 shall take precedence followed by this Laboratory Test Procedure, TP-106-XX, in case of conflict.

NHTSA Documents - -

FMVSS 106, Brake Hoses
OVSC Laboratory Test Procedure No. TP-106-0X

Society of Automotive Engineers (SAE) - -

J1401, Hydraulic Brake Hose, Jan 1967
J1402b, Air Brake Hose, Jan 1970
J1403a, Vacuum Brake Hose, Mar 1973

American Society for Testing of Materials (ASTM) - -

D571-55, Methods of Testing Automotive Hydraulic Brake Hose
B117-64, Methods of Salt Spray (Fog) Testing
D622-65, Methods of Testing Automotive Air Brake and Vacuum Brake Hose
E4-64, Methods of Verification of Testing Machines
D471, Method of Test for Change in Properties of Elastomeric Vulcanizers Resulting from Immersion in Liquids, 1974

Military Specifications (MIL) - -

H-13719, Rubber, Hydraulic Brake Hose Assembly
C-45662A, Calibration System Requirements

The procedure shall contain instructions for the following:

A. Sample tagging or marking

B. Sample stowage

C. Testing setup

D. Testing procedure (step-by-step)

11. PRETEST REQUIREMENTS….Continued

E. Data recording

F. Setup photographs

G. Photographs of sample failure(s) showing samples before and after testing and illustrating point(s) of failure

H. Description of failure(s)

TEST DATA LOSS

A compliance test is not to be conducted unless all of the various test conditions specified in the applicable OVSC Laboratory Test Procedure have been met. Failure of a contractor to obtain the required test data and to maintain acceptable limits on test parameters in the manner outlined in the applicable OVSC Laboratory Test Procedure may require a retest at the expense of the contractor. The retest costs will include the cost of the replacement item of motor vehicle equipment and all costs associated with conducting the retest. The original test specimen used for the invalid test shall remain the property of OVSC, and the retest specimen shall remain the property of the contractor. If there is a test failure, the contractor shall retain the retest specimen for a period not exceeding 2 years. If there is no test failure, the Contractor may dispose of the test specimen upon notification from the COTR that the final test report has been accepted.

The Contracting Officer of NHTSA is the only NHTSA official authorized to notify the contractor that a retest is required. The retest shall be completed within two (2) weeks after receipt of notification by the Contracting Officer that a retest is required. If a retest is conducted, no test report is required for the original test.

TEST CONDITIONS

Unless otherwise specified, all tests and measurements shall be conducted under the following environmental conditions:

A.	Temperature	80°F ± 10°F
B.	Relative Humidity	50% ± 10%
C.	Atmospheric Pressure	28 to 32 inches of Mercury (Hg)

Continuous recording of environmental temperature and relative humidity of the testing area shall be available during all tests. Test samples, unless otherwise specified, shall be stabilized at test room conditions for a period of at least 24 hours immediately prior to testing.

(Continued on next page)

11. PRETEST REQUIREMENTS....Continued

The maximum effect of instrumentation errors and read-out errors must be considered when performing tests, so that steady state parameters and exposure times are not exceeded before pass/fail criteria are applied to the sample.

TEST PERSONNEL PERFORMANCE

Personnel supervising and/or performing the compliance test program shall be thoroughly familiar with the requirements, test conditions, equipment for the test to be conducted, and safety requirements.

RECORDING OF TEST DATA

Environmental data and test data shall be recorded on permanent strip charts, circular recording charts, or other acceptable print-out media. Where permanent trace recording is not required, data will be recorded on standard report forms. Changes or corrections shall be made by drawing a line through the original entry, which must still remain legible, and adding the change alongside.

Test data will be submitted on the standard form Test Data Sheets specified for use in the final test report and shown in Section 15. Data will be typed before the sheets are submitted.

The following test areas will require permanent trace recordings:

HYDRAULIC BRAKE HOSES

(H-3)	Volumetric Expansion Test	Pressure vs. Time
(H-4)	Burst Test	Pressure vs. Time
(H-5)	Whip Test	Pressure, RPM, Time, Room Temp.
(H-6)	Tensile Test	Load vs. Time
(H-7)	Cold Box Test	Temperature vs. Time
(H-8)	Salt Spray Test	Temp. & Concentrations vs. Time
(H-9)	Ozone Test	Temp. & Concentrations vs. Time
(H-11)	Brake Fluid Compatibility Test	Temperature vs. Time

AIR BRAKE HOSES

(A-3)	High Temperature Test	Temperature vs. Time
(A-4)	Cold Box Test	Temperature vs. Time
(A-5)	Oil Resistance Test	Temperature vs. Time
(A-6)	Ozone Test	Temp. & Concentrations vs. Time
(A-8)	Adhesion Test	Force vs. Displacement
(A-9)	Air Pressure Test	Pressure vs. Time
(A-10)	Burst Test	Pressure vs. Time
(A-11)	Tensile Test	Load vs. Time
(A-14)	Salt Spray Test	Temp. & Concentrations vs. Time

11. PRETEST REQUIREMENTS....Continued

VACUUM BRAKE HOSES

(V-3)	High Temperature Test	Temperature vs. Time
(V-4)	Cold Box Test	Temperature vs. Time
(V-5)	Ozone Test	Temp. & Concentrations vs. Time
(V-6)	Burst Test	Pressure vs. Time
(V-10)	Adhesion Test	Force vs. Displacement
(V-12)	Salt Spray Test	Temp. & Concentrations vs. Time

When a sample failure does occur (sample WILL NOT be subjected to further testing), all of the charts and/or recordings for the failed sample or copies thereof shall be retained by the contractor along with the failed specimen unless otherwise directed by the COTR. This shall include a copy of the original operators hand written data as recorded during the test failure.

REPORTING FORMS

The attached forms will be used for submission of data to the COTR. These forms will be reproduced on the Test Laboratory's stationary. One set of the data sheets will be used for each test set of brake hose assemblies. The final report data sheet information shall be typed. One set of data sheets shall consist of the following:

Data Sheets H-1 through H-12 for HYDRAULIC BRAKE HOSES

Data Sheets A-1 through A-15 for AIR BRAKE HOSES

Data Sheets V-1 through V-13 for VACUUM BRAKE HOSES

TEST DATA REPORTING SHEETS

In addition to the instrument recording data (which may be in analog form), all test data shall be recorded, in standard engineering units, on forms specifically prepared for this purpose such as those shown as the data sheet for each test. Changes or corrections of data sheets shall be made by drawing a line through the original entry, which must still remain legible, and adding the change alongside. The initials of the changer shall appear alongside the change.

Data sheets presented in a final form must be typewritten, signed, and include the date of test and date of sign-off. **The Report Number must appear at the top of each Data Sheet**.

SAMPLE INFORMATION AND SUMMARY OF RESULTS

Preceding the test data sheets in the Final Report, there will be test specimen information and a summary of test results. These sheets will describe the articles tested, list the various tests performed, and indicate the result as either Pass (P) or Fail (F) as supported by the information tabulated on the test data sheets.

11. PRETEST REQUIREMENTS….Continued

PARTS DATA AND SUMMARY OF TEST RESULTS

A. On parts data section of the reporting forms, each space shall be filled out. Where data is not present, write "NONE."

B. Where a trademark is present, provide a recognizable sketch.

C. Where the hose assemblies are not in a container, but certification statement is provided, write the statement. Where no certification is provided, write "NONE."

D. Sketch the data-bearing portion of the band on the bottom of the report form if a band is present.

E. A hose, which fails one test phase, shall be subjected to NO FURTHER TESTING unless so directed by the COTR.

12. COMPLIANCE TEST EXECUTION

A. TEST REQUIREMENTS - HYDRAULIC BRAKE HOSES

12.A.1. - LABELING INSPECTION - (See Data Sheets H-1A, B & C)

All hydraulic test specimens shall be subjected to labeling inspection and any markings, if present, are to be recorded.

All hydraulic test specimens, which are represented by a vehicle manufacturer to be used on a specific motor vehicle, need **NOT** have any marking and therefore are **NOT** subjected to any labeling PASS/FAIL criteria.

The data sheets contain a selection matrix allowing designation of the test specimens as being the following:

- **Vehicle Specific Assemblies**
- **Aftermarket Assemblies (NON-OEM)**
- **Special Test Assemblies**

Vehicle Specific Assemblies are those designated by a vehicle manufacturer as being assemblies used on specific vehicle models and generally will be sold and shipped directly to the test contractor by the vehicle manufacturer or those sold by an authorized vehicle dealer and shipped to the test contractor by the dealer or OVSC.

Aftermarket Assemblies are **NON-OEM** hose assemblies, and, whereas the assembly manufacturer may sell the assemblies as replacement assemblies for specific vehicles, the vehicle manufacturer accepts NO responsibility for their performance.

Special Test Assemblies are those that a vehicle manufacturer may provide as surrogate assemblies for particular tests such as may be necessary to fit a particular test machine (generally these will be shorter assemblies that will fit a tensile test machine or a whip test machine). Markings are NOT required on the **Special Test Assemblies**.

HOSE MATERIAL MARKING

The following hydraulic hose information may be present on the hose material of the assemblies to be tested and shall be recorded although the specimens are NOT subject to the PASS/FAIL criteria in all applications. The stripes described in (A) below are NOT required on Vehicle Specific Assemblies. Markings (B) through (F) are NOT required on the brake hose material in any assembly.

(A) Two torque stripes parallel to the longitudinal axes of the hose and placed on opposite sides of the hose. One of the stripes may be interrupted by the

12. COMPLIANCE TEST EXECUTION....Continued

information listed in (B) through (F) to follow, and the second by any other information that the manufacturer may provide. The two torque stripes are NOT required if the end fittings are such as to prevent the assembly from being installed in a twisted orientation in the vehicle.

(B) The letters "DOT"

(C) Hose Manufacturer's Identification

(D) Date of Manufacturer (Month, Day and Year OR Month and Year expressed in numerals).

(E) Nominal Inside Hose Diameter (I.D. in inches or mm)

(F) Expansion Characteristics (HR or HL)

END FITTINGS

End fittings are NOT required to be marked EXCEPT if the assembly does not contain a band. In that case, except for Vehicle Specific Assemblies, at least one of the fittings shall be etched, stamped or embossed with the assembly manufacturer's identification.

HOSE ASSEMBLIES

Except for Vehicle Specific Assemblies, each hydraulic brake hose assembly shall be labeled with a band (unless the option for end fitting marking has been selected) which shall be etched, stamped or embossed with the following.

(A) The letters "DOT"
(B) Manufacturer's Identification

12.A.2. - CONSTRICTION TEST - (See Data Sheet H-2)

All test specimens shall be subjected to this test. This is basically a "go" or "no go" test in which a plug gage (Deltronic Corp. Go-No-Go Plug gages or equivalent) is inserted in the upper end of a hose assembly, which is held vertically, and allowed to drop by gravity through the hose. The hose is acceptable if the gage passes through the hose and can be seen at the lower fitting within one minute of insertion. Failure to appear at the lower fitting shall be considered a test failure.

The constriction gage shall have a plug maximum diameter as follows (same diameter ball or rod is permissible):

- 0.0795" to 0.0798" for 1/8" I.D. hose (3.2 mm)

12. COMPLIANCE TEST EXECUTION....Continued

- 0.1193" to 0.1197" for 3/16" I.D. hose (4.8 mm)
- 0.1591" to 0.1596" for 1/4" I.D. hose (6.3 mm)

The gage plug maximum diameter used by the test laboratory shall be shown to the nearest ten thousandth of an inch, under "REMARKS" on the Data Sheet.

If a constriction does exist, establish the size and approximate location of the constriction. Insert drill rods into the end coupling to determine the maximum size that can be inserted without force. Note size and location on the Data Sheet. Drill rod sizes can be found in the Machinist's Handbook.

12.A.3. - VOLUMETRIC EXPANSION TEST - (See Data Sheet H-3)

GENERAL -

Hoses numbered 1 thru 4 shall be subjected to this test. The test set up shall be in accordance with Figure 1 of FMVSS 106 and shall have the hose and both valves assembled in-line vertically. The normal flow or pressure side of the valve shall be at the bottom towards the pump or pressure source unless otherwise approved by the COTR. The hose shall have no twists or bends and not be subjected to tension when under test. All portions of the test setup exposed to high pressure shall be made of stainless steel tubing to eliminate any measurable expansion except for that due to the hose being tested.

The test fluid shall consist of distilled water and be free of air or gases. If at any time during the test an air bubble flows out of the hose, repeat the test allowing at least 5 minutes without pressure for the hose to contract to its original size when NOT pressurized.

DO NOT REMOVE THE HOSE BETWEEN EXPANSIONS!

All air shall be bled from the system by allowing approximately 1/2 pint of water to flow through the hose and into the burette while gently tapping the hose to shake out any air bubbles.

The sealing surfaces in conventional male and female hose connections shall be used for sealing during the expansion tests. Compression rings may be used for unconventional ends which have long metal tubes attached to the final end fitting. In these cases, the laboratory shall take adequate precaution to remove all trapped air (air can often be flushed out by leaving the connections loose during the initial system water fill).

12. COMPLIANCE TEST EXECUTION....Continued

REQUIREMENTS -
The maximum expansion of a hydraulic brake hose assembly shall not exceed the values specified in Table 1.

PROCEDURE -

After assuring that the system is completely filled with the test fluid and is free from all air or gases, close the upper valve and apply a hydrostatic pressure of 950 to 1,000 psig at the rate of 12,000 to 18,000 psig/minute. Apply 1,450 to 1,500 psig in the second series of tests. Hold this pressure for 3 seconds.

Close the lower valve and open the upper valve for 3 seconds to allow the fluid level in the burette to rise. This should be accomplished 3 times at each pressure yielding 3 hose expansions. The burette reading divided by 3 will give the actual hose expansion.

TABLE 1
MAXIMUM EXPANSION OF FREE LENGTH BRAKE HOSE (cc/ft)

Hydraulic Brake Hose, Inside Diameter (I.D.)	TEST PRESSURE			
	1,000 psi		1,500 psi	
	Regular Expansion Hose	Low Expansion Hose	Regular Expansion Hose	Low Expansion Hose
1/8" or 3 mm or less	0.66	0.33	0.79	0.42
3/16" or 4 mm to 5 mm	0.86	0.55	1.02	0.72
1/4" or 6 mm or more	1.04	0.82	1.30	1.17

This actual hose expansion must then be compared to the Maximum Allowable cc/ft. from Table I by dividing the Actual by the hose free length in ft. to determine the "PASS" or "FAIL" for each hose.

Pressure vs. Time shall be permanently recorded.

12. COMPLIANCE TEST EXECUTION….Continued

12.A.4. - BURST STRENGTH TEST - (See Data Sheet H-4)

Hoses listed below shall be subjected to this test after completion of the prior designated test:

HOSE NO(S).	PRIOR TEST
1 - 4	Volumetric Expansion Test (H-3)
16	Water Absorption Test (H-10)
19	Brake Fluid Compatibility and Constriction Test (H-11)

Hoses, which are subjected to the burst test, need not be burst, but shall be subjected to an internal hydrostatic pressure of 5,000-psig minimums.

The hose internal hydrostatic pressure shall be increased from 0 to between 3,800 to 4,000 psig at a rate of between 12,000 and 18,000 psig/minute. This pressure shall be maintained for a minimum period of 110 seconds and a maximum of 120 seconds, then increased at the rate of between 12,000 and 18,000 psig/minute until 5,000 psig minimum is reached or the hose bursts.

Hydrostatic Pressure vs. Time shall be permanently recorded.

12.A.5. - WHIP (FATIGUE) TEST - (See Data Sheet H-5)

GENERAL -

Hoses numbered 5 thru 8 shall be subjected to this test and Hose #17 shall also be subjected after completion of the Water Absorption Test (H-10).

The whip machine shall be similar to that indicated in SAE J1401 and shall be dynamically balanced without hoses, and suitably mounted to avoid sympathetic vibrations. Hose couplings shall be mounted perpendicularly to the hose-mounting surfaces of the whip machine (movable and stationary headers with no twist in the hose). If at any time during the test, a hose fails due to a machine malfunction, **ALL** of the hoses in the test set shall be replaced by extra hoses from the group under test and the test will be repeated. The extra hoses must undergo the Constriction Test (H-2) prior to the Whip Test.

12. COMPLIANCE TEST EXECUTION....Continued

PREPARATION FOR TEST -

The free length of the hoses to be whip tested shall be measured to within a tolerance of 0.015" with the hose assembly in a straight position using a vernier caliper scale or equivalent. When measuring the free length, the lengths of the end fittings are not included; only the length of the exposed rubber outer cover is measured. Hoses with a free length of less than 8" or more than 24" are not required to be tested.

All external appendages such as chafing collars, removable mounting brackets, date bands and spring guards shall be removed from the brake hose assembly prior to testing on the whip machine. The removed pieces shall be retained for regrouping with each sample until disposal.

The hoses shall be installed on the whip test machine with the slack settings in Table 2.

If a whip test failure occurs, prior to removal of the hose from the whip test machine, two photographs, one from above, and one from the side, shall be taken to show that the hose is not twisted. The torque stripe on the hose will be used as an indicator. The photographs shall be kept on file with the chart recordings. Remove failed hose, replace all hose assemblies with new untested hoses, and repeat the test.

TEST -

Apply the 220 to 235 psig water pressure and bleed all hoses and passages to eliminate air pockets and bubbles.

TABLE 2 - HOSE LENGTHS

Free Length Between End Fittings, inches	SLACK	
	1/8" hose (3 mm) or less	More than 1/8" hose (3 mm)
8 to 15½, inclusive	1.750"	No Test
Over 15½ to 19, inclusive	1.250"	No Test
Over 19 to 24, inclusive	0.750"	No Test
10 to 15½, inclusive		1.000"

The time duration for the whip test shall be 40 hours at a machine speed of 780 to 800 rpm. The criteria for acceptable performance shall be based upon the condition of the hoses after 35 hours of testing.

Pressure, RPM, Room Temperature and Time shall be permanently recorded for this test.

12. COMPLIANCE TEST EXECUTION....Continued

12.A.6. - TENSILE STRENGTH TEST - (See Data Sheet H-6)

Hoses numbered 9 thru 12 shall be subjected to this test and Hose #18 shall also be subjected after completion of the Water Absorption Test (H-10).

The tension test consists of subjecting the hose assembly to increasing tensile load in a suitable testing machine until failure occurs, either by -

(A) Separation of the specimen from the end fittings, OR
(B) Failure of the hose structure

A tensile testing machine, which conforms to the requirements of ASTM Methods, E4, "Verification of Testing Machines," shall be used. A machine of 1,000 lbs. capacity is sufficient. After removal of any hose armor or date bands, etc., the hose assembly fittings shall be attached to the machine by suitable fixtures so that the hose and fittings shall have a straight center line parallel to the direction of the machine pull. Tensile pull shall be applied at the rate of 1" ± 0.1" per minute. All hose assemblies shall withstand a minimum pull of 325 lbs.

The tensile machine shall be provided with a recording device such as an X-Y Plotter, to give the total pull (pounds) at the conclusion of the test.

12.A.7. - COLD BOX TEST - (See Data Sheet H-7)

Hose #13 shall be subjected to this test. After removal of any hose armor, date bands, etc., the hose shall be placed in the cold box on a low conductivity material such as wood. A wood mandrel of the size noted below shall be conditioned with the test hose:

HOSE I.D.	MANDREL DIAMETER (+ 0.03", -0")
Less than 1/8"	2.50"
1/8"	3.00"
3/16" and 1/4"	3.50"
Greater than 1/4"	4.00"

The cold box 70 hour test period shall begin when the box recorded temperature stabilizes at -35° to -40°F. The hoses are to be conditioned in the cold box in the "free" position and after 70 hours are to be bent around the mandrel favoring any natural curvature already in the hose. The bending operation shall occur in the cold box.

12. COMPLIANCE TEST EXECUTION....Continued

The hose assembly shall be wrapped around the mandrel 180° by hand at a steady rate in 3 to 5 seconds, using suitable gloves, and holding the hose rather than grasping the end couplings.

After bending and removal from the cold box, inspect the outer rubber cover for cracks. Cut the hose lengthwise to expose the inner liner for its inspection for cracks. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.

The Cold Box Temperature vs. Time shall be permanently recorded.

12.A.8. - SALT SPRAY TEST - (See Data Sheet H-8)

Hose #14 shall be subjected to this test. Utilize the apparatus described in ASTM B117-64, "Salt Spray (Fog) Testing."

CONSTRUCTION -

Construct the salt spray chamber so that:

(A) The construction material does not affect the corrosiveness of the fog.

(B) The hose assembly is shorted or suspended 30° from the vertical and parallel to the principal direction of the horizontal flow of fog through the chamber.

(C) The hose assembly does not contact any metallic material or any material capable of acting as a wick.

(D) Condensation which falls from the assembly does not return to the solution reservoir for respraying.

(E) Condensation from any source does not fall on the brake hose assemblies or the solution collectors.

(F) Spray from the nozzles is NOT directed directly onto the hose assembly.

PREPARATION -

(A) Plug each end of the hose assembly.

(B) Mix a salt solution five parts by weight of sodium chloride to 95 parts of distilled water, using sodium chloride substantially free of nickel and copper, and containing on a dry basis not more than 0.1 percent of sodium iodide and not more than 0.3 percent total impurities.

12. COMPLIANCE TEST EXECUTION....Continued

Insure that the solution is free of suspended solids before the solution is atomized.

(C) After atomization at 95ºF ensure that the collected solution is in the PH range of 6.5 to 7.2. Make the measurements at 77ºF.

(D) Maintain a compressed air supply to the nozzle or nozzles free of oil and dirt and between 10 and 25 psi.

OPERATION -
Subject the brake hose assembly to the salt spray continuously for 24 hours. If the nozzles used have a critical air pressure, which causes hyper-corrosive fog between 10 and 25 psi, this pressure shall be avoided by at least 2 psi.

(A) Regulate the mixture so that each collector will collect from 1 to 2 ml. of solution per hour for each 80 square centimeters of horizontal collecting area.

(B) Maintain exposure zone temperature at 95ºF ± 2ºF.

(C) Upon completion, remove the salt deposit from the surface of the hoses by washing gently or dipping in clean running water not warmer than 100ºF and then drying immediately.

(D) Chamber Temperature and Concentrations vs. Time must be permanently recorded.

INSPECTION -
A brake hose end fitting shall show no base metal corrosion on the and fitting surface except where crimping or the application of labeling information has caused displacement of the protective coating. Salt spray corrosion shall be noted as presence of red rust in the case of coated ferrous couplings and pitting in the case of brass couplings.

12.A.9. - OZONE TEST - (See Data Sheet H-9)

Hose #15 shall be subjected to this test.

PREPARATION -

Remove all hose armor, date bands, etc., and utilizing a cylinder with a diameter eight times the nominal outside diameter (+ 0.03, - 0) of the brake hose, bind the brake hose 360º around the cylinder. In the case of hose shorter than the circumference of the cylinder, bend the hose so that as much of its length as possible is in contact.

12. COMPLIANCE TEST EXECUTION....Continued

EXPOSURE TO OZONE -

(A) Condition the hose on the cylinder in air at room temperature for 24 hours minimum.

(B) Immediately thereafter, condition the hose on the cylinder for 70 hours in an exposure chamber having an ambient air temperature of 98ºF to 104ºF during the test and containing air mixed with ozone in the proportion of 50 parts of ozone per 100 million parts of air by volume.

(C) Examine the hose for cracks under 7-power magnification, ignoring areas immediately adjacent to or within the area covered by binding. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.

(D) Chamber Temperature and Concentrations vs. Time must be permanently recorded.

12.A.10. - WATER ABSORPTION TEST - (See Data Sheets H-10A, H-10B, H-10C)

Hoses numbered 16 thru 18 shall be subjected to this test.

PREPARATION -

Prepare three (3) hose assemblies as follows:

(A) Remove 1-1/8 inches of hose cover, if any, from the center of the hose assemblies without injury to any reinforcing material or elongation of the hose assemblies.

(B) Measure the free length of the hose assemblies.

IMMERSION AND SEQUENCE TESTING -

(A) Immerse the hose assemblies in distilled water for 68 to 70 hours.

(B) Within 30 minutes after removal from the water, the following tests shall be started:

Hose #16 - BURST STRENGTH TEST (Paragraph 12.A.4)

Hose #17 - WHIP (FATIGUE) TEST (Paragraph 12.A.5)

Hose #18 - TENSILE STRENGTH TEST (Paragraph 12.A.6)

12. COMPLIANCE TEST EXECUTION....Continued

12.A.11. - BRAKE FLUID COMPATIBILITY TEST - (See Data Sheet H-11)

Hose #19 shall be subjected to this test.

PREPARATION -

(A) Attach a hose assembly below a 1-pint reservoir filled with 100 ml of SAE RM-66-03 Compatibility Fluid or with SAE RM-66-04 Compatibility Fluid.

(B) Fill the hose assembly with the compatibility fluid, seal the lower end, and place the test assembly in an oven in a vertical position.

OVEN TREATMENT -

(A) Condition the hose assembly at 195ºF to 200ºF for 70 hours. Temperature vs. Time shall be permanently recorded.

(B) Cool the hose assembly at room temperature for 30 minutes minimum.

(C) Drain the fluid from the brake hose and perform the Constriction Test in accordance with Paragraph 12.A.2.

(D) Immediately following the test above, perform a Burst Strength Test in accordance with Paragraph 12.A.4.

12.A.12. - TRACER CORD IDENTIFICATION - (See Data Sheet H-12)

This paragraph is provided for information only to aid in further hose identification, if required, particularly in the event of illegible hose/fitting identification.

All hoses within the group with the exception of the "FAILED" sample shall be subjected to this test. To determine the tracer cord color, carefully remove one section of the outer rubber cover (approximately 2 inches long and one-half way around the hose) to expose the outer ply of the braid, and identify the color of the tracer cord. Where no tracer cord is present in the outer braid, expose the surface of the inner braid.

State the color or colors found and refer to the R.M.A. Code Assignments, "Colored Yarn Manufacturers Identification," to add the name of the hose manufacturer. If no identification is present in either braid, write "NONE" in the space on the data sheet. The R.M.A. Code Assignments may be obtained from the Rubber Manufacturers Association, Inc., 1400 K Street, NW, Washington, DC 20005 (Attention Mr. Stephen Butcher, Telephone Number 202-682-4818).

12. COMPLIANCE TEST EXECUTION....Continued

B. TEST REQUIREMENTS - AIR BRAKE HOSES

12.B.1. - LABELING INSPECTION - (See Data Sheets A-1A, B & C)

All air hose test specimens shall be subjected to labeling inspection and any markings, if present, are to be recorded.
The data sheets contain a selection matrix allowing designation of the test specimens as being the following:

- **Vehicle Specific Assemblies**
- **Aftermarket Assemblies (NON-OEM)**
- **Special Test Assemblies**

Vehicle Specific Assemblies are those designated by a vehicle manufacturer as being assemblies used on specific vehicle models and generally will be sold and shipped directly to the test contractor by the vehicle manufacturer or those sold by an authorized vehicle dealer and shipped to the test contractor by the dealer or OVSC.

Aftermarket Assemblies are **NON-OEM** hose assemblies, and, whereas the assembly manufacturer may sell the assemblies as replacement assemblies for specific vehicles, the vehicle manufacturer accepts NO responsibility for their performance.

Special Test Assemblies are those that a vehicle manufacturer may provide as surrogate assemblies for particular tests such as may be necessary to fit a particular test machine (generally these will be shorter assemblies that will fit a tensile test machine). Markings are NOT required on the **Special Test Assemblies**.

HOSE MATERIAL MARKING

Although NOT required on hose material of assemblies to be tested, the following hose information shall be recorded if present.

(A) The letters "DOT"

(B) Hose Manufacturer's Identification

(C) Date of Manufacturer (Month, Day and Year OR Month and Year expressed in numerals).

(D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing followed by the letters "OD"

(E) The letters A, AI or AII

12. COMPLIANCE TEST EXECUTION....Continued

END FITTINGS (Non-crimped or Swaged type)

At least one component of any non-crimped or swaged type end fitting shall be marked with the following information.

(A) The letters "DOT"

(B) Manufacturer's Identification
(C) The letters A, AI or AII

(D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing following by the letters "OD"

HOSE ASSEMBLIES (Crimped or swaged type end fittings)

Hose assemblies with fittings attached by crimping or swaging have two (2) options for marking.

OPTION 1: Marking shall be on a band and shall consist of the following:

(A) The letters "DOT"
(B) Manufacturer's identification

OPTION 2: The manufacturer's Identification shall be marked on at least one end fitting

Hose assemblies with fittings other than crimped or swaged have NO assembly labeling requirements.

12.B.2. - CONSTRICTION TEST - (See Data Sheet A-2)

All test specimens shall be subjected to this test. This shall be conducted following the same procedure and with the same plug gages as specified previously. The constriction gage shall have a plug maximum diameter as follows: (Same diameter ball or rod is permissible)

0.0820" to 0.0823"	for 1/8" hose	(3.2 mm)
0.1230" to 0.1234"	for 3/16" hose	(4.8 mm)
0.1641" to 0.1646"	for 1/4" hose	(6.3 mm)
0.2051" to 0.2057"	for 5/16" hose	(7.9 mm)
0.2461" to 0.2469"	for 3/8" hose	(9.5 mm)
0.2666" to 0.2674"	for 13/32" hose	(10.3 mm)
0.2870" to 0.2879"	for 7/16" hose	(11.1 mm)
0.3281" to 0.3291"	for 1/2" hose	(12.7 mm)
0.4104" to 0.4115"	for 5/8" hose	(15.9 mm)

12. COMPLIANCE TEST EXECUTION....Continued

NOTE: Hose marked as 3/8 O.D. shall be considered as a 1/4 inch Nominal Inside Diameter (I.D.).

The gage plug maximum diameter used by the test laboratory shall be shown to the nearest ten thousandth of an inch, under "REMARKS" on the Data Sheet.

If a constriction does exist, establish the approximate size of the opening in the failed sample. Insert drill rods into the end coupling to determine the maximum size that can be inserted without force. Note the size and location on the Data Sheet. Drill rod sizes can be found in the Machinist's Handbook.

12.B.3. - HIGH TEMPERATURE TEST - (See Data Sheet A-3)

Hose #1 shall be subjected to this test. Use a cylinder of the diameter noted on the next page for the specific hose diameter being tested.

Secure the test hose around the cylinder for 180° minimum and place the assembly in an air oven for 70 hours. Maintain the temperature at 207 to 212°F.

Temperature vs. Time shall be permanently recorded.

Remove the hose and cylinder from the oven and allow to cool to room temperature. Hand straighten the hose and inspect for external cracks, charring or disintegration. Cut the hose lengthwise and inspect internally for any test damage.

HOSE NOMINAL I.D.	TEST CYLINDER DIAMETER (+0.03", -0")
1/8"	3.00"
3/16"	4.00"
1/4" or 3/8"OD	5.00"
5/16"	6.00"
3/8"	7.00"
13/32"	7.00"
7/16"	8.00"
1/2"	8.00"
5/8"	9.00"

12. COMPLIANCE TEST EXECUTION....Continued

12.B.4. - COLD BOX TEST - (See Data Sheet A-4)

Hose #2 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.7 except the wood mandrel shall be as stated in Paragraph 12.B.3.

12.B.5. - OIL RESISTANCE TEST - (See Data Sheet A-5)

Hoses numbered 3 thru 5 shall be subjected to this test.

NOTE: A minimum of three (3) hoses must be used for this test.
PREPARATION -

Fabricate the three test specimens by cutting blocks 2 inches long and 3/8 of an inch in width, having a thickness of not more than one-sixteenth inch, from the brake hose inner tube and buff the specimens on both faces to ensure smooth surfaces.

MEASUREMENT -

(A) Weigh each specimen to the nearest milligram in air (WI) and in distilled water (W2) at room temperature. If wetting is necessary to remove air bubbles, dip the specimen in acetone and thoroughly rinse it with distilled water.

(B) Immerse each specimen in ASTM No. 3 oil for 70 hours at 212°F and then cool in ASTM No. 3 oil at room temperature for 30 to 60 minutes.

(C) Dip the specimen quickly in acetone and blot it lightly with filter paper.

(D) Weigh each specimen in a tared weighing bottle (W3) and in distilled water (W4) within 5 minutes of removal from the cooling liquid.

(E) Calculate the percentage increase in volume as follows:

$$\text{Percent of Increase} = \{[(W_3 - W_4) - (W_1 - W_2)] / (W_1 - W_2)\} \times 100$$

(F) Enter the data on Data Sheet A-5 and average the three results.

12.B.6. - OZONE TEST - (See Data Sheet A-6)

Hose #6 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.9.

12. COMPLIANCE TEST EXECUTION....Continued

12.B.7. - LENGTH CHANGE TEST - (See Data Sheet A-7)

Hose #7 shall be subjected to this test.

(A) Position a test hose in a straight, horizontal position, and apply air pressure of 9.5 to 10 psig.

(B) Measure the hose to determine original free length.

(C) Without releasing the 10 psi, raise the air pressure to the test hose to 195 to 200 psi.

(D) Measure the hose under 200 psi to determine final free length. An elongation or contraction is an increase or decrease, respectively, in the final free length from the original free length of the hose.

12.B.8. - ADHESION TEST - (See Data Sheet A-8)

NOTE: This test shall not be performed on hose stock with internal steel cord.

Hose #8 shall be subjected to this test.

APPARATUS -

Utilize a power-driven apparatus of the inclination balance or pendulum type which is constructed so that:

(A) The recording head includes a freely rotating form with an Outside Diameter (O.D.) substantially the same as Inside Diameter (I.D.) of the hose specimen to be placed on it.

(B) The freely rotating form is mounted so that its axis of rotation is in the plane of the ply being separated from the specimen and so that the applied force is perpendicular to the tangent of the specimen circumference at the line of separation.

(C) The rate of travel of the power-actuated grip is a uniform 1 inch per minute and the capacity of the load cell is such that the maximum applied tension during the test is not more than 85 percent nor less than 15 percent of the load cell's rated capacity.

(D) The machine operates with no device for maintaining maximum load indication, and in a pendulum type machine, the weight lever swings as a free pendulum without engagement of pawls.

12. COMPLIANCE TEST EXECUTION....Continued

(E) The machine produces a chart with inches of separation as one coordinate and applied tension as the other.

PREPARATION -

(A) Cut a test specimen of 1 inch or more in length from the hose to be tested and cut the layer to be tested of that test specimen longitudinally along its entire length to the level of contact with the adjacent layer. Record specimen length on data sheet.

(B) Peel the layer to be tested from the adjacent layer to create a flap large enough to permit attachment of the power-actuated clamp of the apparatus.

(C) Mount the test specimen on the freely rotating form with the separated layer attached to the power-actuated clamp.

CALCULATIONS -

(A) The adhesion value shall be the minimum force recorded on the chart excluding that portion of the chart which corresponds to the initial and final 20 percent portion along the displacement axis.

(B) Express the force in pounds per inch of length.

12.B.9. - AIR PRESSURE TEST - (See Data Sheet A-9)

Hose #9 shall be subjected to this test. Connect the hose to a source of air pressure and pressurize to 195 to 200 psig. Isolate the hose from the pressure source and record the pressure remaining in the hose after a 5 minute ($\pm$ 5 second) hold period.

The air pressure within the hose shall not decrease more than 5 psig from the initial pressure (195 to 200 psig).

Pressure vs. Time shall be permanently recorded.

12.B.10. - BURST STRENGTH TEST - (See Data Sheet A-10)

Hose #10 shall be subjected to this test. After the hose is filled with water and all air bled from the system, increase the hydrostatic pressure at the rate of 800 to 1,000 psig per minute until the hose bursts or the fitting separates. Minimum allowable burst pressure is 800 psig.

Pressure vs. Time shall be permanently recorded.

12. COMPLIANCE TEST EXECUTION....Continued

12.B.11. - TENSILE STRENGTH TEST - (See Data Sheet A-11)

Hose #11 shall be subjected to this test and Hose #12 shall also be subjected after completion of the Water Absorption Test (A-12).

The test shall be conducted in accordance with Paragraph 12.A.6 except that the allowable tensile strengths in pounds are shown below.

Vehicle Application	ALLOWABLE TENSILE STRENGTH		
	Hose Size 1/4" or less	Hose Size 3/8" or 1/2"	Hose Size 1/2" or larger
Relative Motion (axle to body)	250 lbs	325 lbs	325 lbs
No Relative Motion	50 lbs	150 lbs	325 lbs

NOTE: All hoses shall meet the relative motion requirement unless notified otherwise by the COTR.

12.B.12. - WATER ABSORPTION TEST - (See Data Sheet A-12)

Hose #12 shall be subjected to this test. Immerse the hose in distilled water at room temperature for 68 to 70 hours. Within 30 minutes after removal from the water, conduct the Tensile Strength Test (A-11) in accordance with Paragraph 12.B.11.

12.B.13. - ZINC CHLORIDE RESISTANCE TEST - (See Data Sheet A-13)

Hose #13 shall be subjected to this test.

Immerse the hose in a 50 percent zinc chloride aqueous solution at room temperature for 200 hours. Remove it from the solution and examine it under 7-power magnification for cracks. An external fabric braid may have to be removed to expose the outer rubber cover for inspection.

12.B.14. - SALT SPRAY TEST - (See Data Sheet A-14)

Hose #14 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.8.

12.B.15. - TRACER CORD IDENTIFICATION - (See Data Sheet A-15)

Perform the identification in accordance with Paragraph 12.A.12.

12. COMPLIANCE TEST EXECUTION….Continued

C. TEST Requirements - VACUUM BRAKE HOSES

12.C.1. - LABELING INSPECTION - (See Data Sheets V-1A, B & C)

All vacuum hose test specimens shall be subjected to labeling inspection and any markings, if present, are to be recorded.

The data sheets contain a selection matrix allowing designation of the test specimens as being as follows:

- **Vehicle Specific Assemblies**
- **Aftermarket Assemblies (NON-OEM)**
- **Special Test Assemblies**

Vehicle Specific Assemblies are those designated by a vehicle manufacturer as being assemblies used on specific vehicle models and generally will be sold and shipped directly to the test contractor by the vehicle manufacturer or those sold by an authorized vehicle dealer and shipped to the test contractor by the dealer or OVSC.

Aftermarket Assemblies are **NON-OEM** hose assemblies, and, whereas the assembly manufacturer may sell the assemblies as replacement assemblies for specific vehicles, the vehicle manufacturer accepts NO responsibility for their performance.

Special Test Assemblies are those that a vehicle manufacturer may provide as surrogate assemblies for particular tests such as may be necessary to fit a particular test machine (generally these will be shorter assemblies that will fit a tensile test machine). Markings are NOT required on the **Special Test Assemblies**.

HOSE MATERIAL MARKING

Although NOT required on hose material of assemblies to be tested, the following hose information shall be recorded if present.

(A) The letters "DOT"

(B) Hose Manufacturer's Identification

(C) Date of Manufacturer (Month, Day and Year OR Month and Year expressed in numerals).

(D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing followed by the letters "OD"

(E) The letters VL or VH

12. COMPLIANCE TEST EXECUTION....Continued

END FITTINGS (Reusable fittings only)

Except for an end fitting that is attached by heat shrinking or by interference fit with plastic vacuum hose or that is attached by deformation of the fitting about a hose by crimping or swaging, at least one component of any end fitting shall be marked with the following information.

(A) The letters "DOT"

(B) Manufacturer's Identification

(C) The letters VL or VH

(D) Nominal Inside Hose Diameter (I.D. in inches or mm) or the Nominal Outside Diameter (O.D.) of plastic tubing following by the letters "OD"

HOSE ASSEMBLIES (Nonreusable end fittings only)

Hose assemblies with nonreusable end fittings have two (2) options for marking.

OPTION 1: Marking shall be on a band and shall consist of the following:

(A) The letters "DOT"

(B) Manufacturer's identification

OPTION 2: The manufacturer's Identification shall be marked on at least one end fitting

Hose assemblies with reusable end fittings have NO assembly labeling requirements.

12.C.2. - CONSTRICTION TEST - (See Data Sheet V-2)

All test specimens shall be subjected to this test. This test shall be conducted following the same procedure and with the same plug gages as gages in Section 12.A.2. The constriction gage shall have a plug maximum diameter as follows on the next page: (Same diameter ball or rod is permissible).

12. COMPLIANCE TEST EXECUTION....Continued

	PLUG DIAMETER	
HOSE NOMINAL DIAMETER	**VH HOSE (HEAVY DUTY)**	**VL HOSE (LIGHT DUTY)**
7/32"	0.1634" - 0.1638"	0.1524" - 0.1528"
1/4"	0.1866" - 0.1871"	0.1741" - 0.1746"
9/32"	0.2098" - 0.2104"	0.1958" - 0.1964"
11/32"	0.2565" - 0.2572"	0.2393" - 0.2400"
3/8"	0.2798" - 0.2806"	0.2610" - 0.2618"
15/32"	0.3499" - 0.3508"	0.3264" - 0.3273"
1/2"	0.3731" - 0.3741"	0.3481" - 0.3491"
5/8"	0.4667" - 0.4678"	0.4354" - 0.4365"
3/4"	0.5602" - 0.5614"	0.5227" - 0.5239"
1.0"	0.7475" - 0.7488"	0.6975" - 0.6988"

The gage plug maximum diameter used by the test laboratory shall be shown to the nearest ten thousandth of an inch, under "REMARKS" on the Data Sheet.

If a constriction does exist, establish the approximate size of the opening in the failed sample. Insert drill rods into the end coupling to determine the maximum size that can be inserted without force. Note the size and location on the Data Sheet. Drill rod sizes are shown in the Machinist's Handbook.

12.C.3. - HIGH TEMPERATURE TEST - (See Data Sheet V-3)

Hose #1 shall be subjected to this test. Use a cylinder of the diameter noted in Table 3 for the specific hose diameter being tested. Perform the test in accordance with Paragraph 12.B.3.

12.C.4. - COLD BOX TEST - (See Data Sheet V-4)

Hose #2 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.7 except the wood mandrel shall be as stated in Table 3.

12.C.5. - OZONE TEST - (See Data Sheet V-5)

Hose #3 shall be subjected to this test. Perform this test in accordance with Paragraph 12.A.9.

12. COMPLIANCE TEST EXECUTION....Continued

12.C.6. - BURST STRENGTH TEST - (See Data Sheet V-6)

Hose #4 shall be subjected to this test. Perform the test in accordance with Paragraph 12.B.10 except that the minimum allowable burst strength shall be 350 psig.

12.C.7. - VACUUM TEST - (See Data Sheet V-7)

Hose #5 shall be subjected to this test, and Hose #7 shall also be subjected after completion of the Swell Test (V-9), utilizing a 12-inch long vacuum brake hose assembly sealed at one end, as follows:

(A) Measure the hose Outside Diameter (O.D.).
(B) Attach the hose to a source of vacuum and subject it to a vacuum of 25 to 26 inches of Hg for 5 minutes.
(C) Measure the hose to determine the minimum outside diameter while the hose is still subject to vacuum.

12.C.8. - BEND TEST - (See Data Sheet V-8)

Hose #6 shall be subjected to this test.

(A) Bend a vacuum brake hose, of the length prescribed in Table 3 (shown on the next page), in the direction of its normal curvature until the ends just touch as shown in Figure 3 of FMVSS 106.

(B) Measure the outside diameter of the specimen at point A before and after bending.

(C) The difference between the two measurements is the collapse of the hose Outside Diameter on bending. The allowable maximum collapse is shown in Table 3.

12.C.9. - SWELL TEST - (See Data Sheet V-9)

Hose #7 shall be subjected to this test.

(A) Fill a specimen of vacuum brake hose 12 inches long with Reference Fuel A as described in either of the following:

ASTM D471-64 - Method of Test for Change in Properties of Elastomeric Vulcanizers Resulting from Immersion in Liquids

ASTM D622-65 - Methods of Testing Automotive Air Brake and Vacuum Brake Hose

12. COMPLIANCE TEST EXECUTION....Continued

TABLE 3

VACUUM BRAKE HOSE TEST REQUIREMENTS

Hose Inside Dia. (I.D.)	High Temperature Resistance		High Temperature Resistance		Bend		Deformation-Collapsed Inside Dia. (Dimen. D)
	Hose Length	Dia. of Cylinder (+.03,-0)	Hose Length	Dia. of Cylinder (+.03,-0)	Hose Length	Max. Collapse of Outside Dia. (O.D.)	
7/32"	8"	3"	17.5"	6"	7"	11/64"	3/64"
1/4"	9"	3"	17.5"	6"	8"	3/32"	1/16"
9/32"	9"	3.5"	19"	7"	9"	12/64"	4/64"
11/32"	9"	3.5"	19"	7"	11"	13/64"	5/64"
3/8"	10"	3.5"	19"	7"	12"	5/32"	3/32"
15/32"	11"	4"	20.5"	8"	14"	17/64"	5/64"
1/2"	11"	4"	20.5"	8"	16"	7/32"	1/8"
5/8"	12"	4.5"	22"	9"	22"	7/32"	5/32"
3/4"	14"	5"	24"	10"	28"	7/32"	3/16"
1"	16"	6.5"	28.5"	13"	36"	9/32"	1/4"

12. COMPLIANCE TEST EXECUTION....Continued

(B) Maintain reference fuel in the hose under atmospheric pressure at room temperature for 48 hours.

(C) Remove the fuel and perform the Constriction Test (V-2) in accordance with Paragraph 12.C.2.

(D) Perform the Vacuum Test (V-7) in accordance with Paragraph 12.C.7 except the vacuum shall be held for 10 minutes. The hose shall not collapse under these vacuum conditions.

12.C.10. - ADHESION TEST - (See Data Sheet V-10)

Hose #8 shall be subjected to this test. Perform the test in accordance with Paragraph 12.B.8. Not applicable to hoses with internal steel wires.

12.C.11. - DEFORMATION TEST - (See Data Sheet V-11)

Hose #9 shall be subjected to this test. The vacuum brake hose shall return to 90 percent of its original outside diameter within 60 seconds after five applications of force as specified herein. In the case of heavy-duty hose the first application of force shall not exceed a peak value of 70 pounds, and the fifth application of force shall reach a peak value of at least 40 pounds. In the case of light-duty hose the first application of force shall not exceed a peak value of 50 pounds, and the fifth application of force shall reach a peak value of at least 20 pounds. Table 4 (shown on the next page) specifies the test specimen dimensions.

APPARATUS -

Utilize a compression device, equipped to measure force of at least 100 pounds, and feeler gages of sufficient length to be passed completely through the test specimens.

OPERATION -

(A) Position the test specimen longitudinally in the compression device with the fabric laps not in the line of the applied pressure.

(B) Apply gradually increasing force to the test specimen to compress its Inside Diameter to that specified in Table 4 (dimension D of Figure 5) for the size of hose tested.

(C) After 5 seconds release the force and record the peak load applied.

(D) Repeat the procedure four times permitting a 10-second recovery period between load applications.

12. COMPLIANCE TEST EXECUTION....Continued

12.C.12. - SALT SPRAY TEST - (See Data Sheet V-12)

Hose #10 shall be subjected to this test. Perform the test in accordance with Paragraph 12.A.8.

TABLE 4

DIMENSIONS OF TEST SPECIMEN AND FEELER GAGE FOR DEFORMATION TEST

Inside Dia. (I.D.) Of Hose	Specimen Dimensions (see Figure 5)		Feeler Gage Dimensions	
	"D" Dimension	"L" Dimension	Width	Thickness
7/32"	3/64"	1"	1/8"	3/64"
1/4"	1/16"	1"	1/8"	1/16"
9/32"	1/16"	1"	1/8"	1/16"
11/32"	5/64"	1"	3/16"	5/64"
3/8"	3/32"	1"	3/16"	3/32"
15/32"	5/64"	1"	1/4"	5/64"
1/2"	1/8"	1"	1/4"	1/8"
5/8"	5/32"	1"	1/4"	5/32"
3/4"	3/16"	1"	1/4"	3/16"
1.0"	1/4"	1"	1/4"	1/4"

12.C.13. - TRACER CORD IDENTIFICATION - (See Data Sheet V-13)

Perform the identification in accordance with Paragraph 12.A.12.

DEFORMED SPECIMEN OF VACUUM BRAKE HOSE

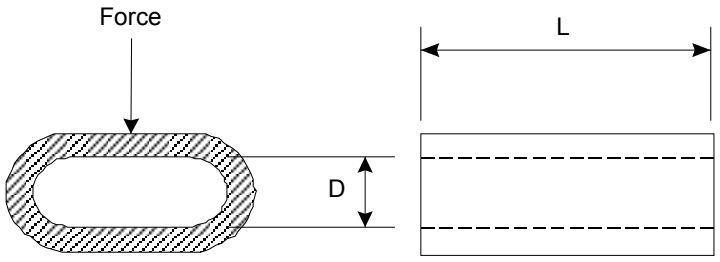

FIGURE 5

13. POST TEST REQUIREMENTS

The contractor shall re-verify all instrumentation and check data sheets and photographs. Make sure that data is recorded in all applicable data blocks on every Data Sheet.

14. REPORTS

14.1 MONTHLY STATUS REPORTS

The contractor shall submit a monthly Test Status Report and an Equipment Status Report to the COTR. The Equipment Status Report shall be submitted until all final reports are accepted. Samples of the required Monthly Status Reports are contained in the report forms section.

14.2 APPARENT TEST FAILURE

Any indication of a test failure shall be communicated by telephone to the COTR within 1 working day with written notification mailed within 2 working days. A Notice of Test Failure (see report forms section) with a copy of the particular compliance test data sheet(s) shall be included.

In the event of a test failure, a post test calibration check of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COTR's discretion and shall be performed without additional costs to the OVSC.

14.3 FINAL TEST REPORTS

14.3.1 COPIES

In the case of a test failure, **SEVEN** copies of the Final Test Report shall be submitted to the COTR for acceptance within three weeks of test completion. The Final Test Report format to be used by all contractors can be found in the attachment.

Where there has been no indication of a test failure, **FOUR** copies of each Final Test Report shall be submitted to the COTR within three weeks of test completion. Payment of contractor's invoices for completed compliance tests may be withheld until the Final Test Report is accepted by the COTR. Contractors are requested to NOT submit invoices before the COTR is provided copies of the Final Test Report.

Contractors are required to submit the first Final Test Report in typed draft form within two weeks after the compliance test is conducted. The contractor and the COTR will then be able to discuss the details of both test conduct and report content early in the compliance test program.

Contractors are required to PROOF READ all Final Test Reports before submittal to the COTR. The OVSC will not act as a report quality control office for contractors. Reports containing a significant number of errors will be returned to the contractor for correction, and a "hold" will be placed on invoice payment for the particular test.

14. REPORTS….Continued

14.3.2 REQUIREMENTS

The Final Test Report, associated documentation (including photographs) are relied upon as the chronicle of the compliance test. The Final Test Report will be released to the public domain after review and acceptance by the COTR. For these reasons, each final report must be a complete document capable of standing by itself.

The contractor should use **detailed** descriptions of all compliance test events. Any events that are not directly associated with the standard but are of technical interest should also be included. The contractor should include as much **detail** as possible in the report.

Instructions for the preparation of the first three pages of the final test report are provided below for the purpose of standardization.

14.3.3 FIRST THREE PAGES

A. FRONT COVER

A heavy paperback cover (or transparency) shall be provided for the protection of the final report. The information required on the cover is as follows:

(1) Final Report Number such as 106-ABC-9X-001

where —
106 is the FMVSS tested
ABC are the initials for the laboratory
9X is the Fiscal Year of the test program
001 is the Group Number (001 for the 1st brand, 002 for the 2nd brand, etc.)

(2) Final Report Title And Subtitle such as

SAFETY COMPLIANCE TESTING FOR FMVSS 106
Brake Hoses
* * * * * * * * * * * * * * * * *
ACE Manufacturing
Sure-Safe Type 21 Air Brake Hose

(3) Contractor's Name and Address such as

COMPLIANCE TESTING LABORATORIES, INC.
4335 West Dearborn Street
Detroit, Michigan 48090-1234

14. REPORTS….Continued

NOTE: DOT SYMBOL WILL BE PLACED BETWEEN ITEMS (3) AND (4)

(4) Date of Final Report completion

(5) The words "FINAL REPORT"

(6) The sponsoring agency's name and address as follows

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Safety Assurance
Office of Vehicle Safety Compliance
Room 6115 (NSA-32)
400 Seventh Street, SW
Washington, DC 20590

14. REPORTS….Continued

B. FIRST PAGE AFTER FRONT COVER

A disclaimer statement and an acceptance signature block for the COTR shall be provided as follows

This publication is distributed by the U. S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Prepared By: _____

Approved By: _____

Approval Date: _____

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By: _____

Acceptance Date: _____

14. REPORTS….Continued

C. SECOND PAGE AFTER FRONT COVER

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Block 3 — RECIPIENT'S CATALOG NUMBER

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Block 4 — TITLE AND SUBTITLE

Final Report of FMVSS 106 Compliance Testing of Sure-Safe Type 21 Air Brake Hose, Part No. 8456782

Block 5 — REPORT DATE

March 1, 199X

Block 6 — PERFORMING ORGANIZATION CODE

ABC

Block 7 — AUTHOR(S)

John Smith, Project Manager
Bill Doe, Project Engineer

Block 8 — PERFORMING ORGANIZATION REPORT NUMBER

ABC-DOT-XXX-001

Block 9 — PERFORMING ORGANIZATION NAME AND ADDRESS

ABC Laboratories
405 Main Street
Detroit, MI 48070-1234

14. REPORTS….Continued

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Block 11 — CONTRACT OR GRANT NUMBER

DTNH22-9X-D-12345

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Safety Assurance
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Washington, DC 20590

Block 13 — TYPE OF REPORT AND PERIOD COVERED

Final Test Report
Feb. 15 to Mar. 15, 199X (Start Date to Completion Date)

Block 14 — SPONSORING AGENCY CODE

NSA-30

Block 15 — SUPPLEMENTARY NOTES

Leave blank

Block 16 — ABSTRACT

Compliance tests were conducted on Sure-Safe Type 21 Air Brake Hoses in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-106-XX for the determination of FMVSS 106 compliance. Test failures identified were as follows:

None

NOTE: Above wording must be shown with appropriate changes made for a particular compliance test. Any questions should be resolved with the COTR.

14. REPORTS….Continued

Block 17 — KEY WORDS

Compliance Testing
Safety Engineering
FMVSS 106

Block 18 — DISTRIBUTION STATEMENT

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14. REPORTS….Continued

13.3.4 TABLE OF CONTENTS

Final test report Table of Contents shall include the following:

A. Section 1 — Purpose of Compliance Test

B. Section 2 — Compliance Test Data Summary

C. Section 3 — Test Data

D. Section 4 — Test Failure Details (if applicable)

E. Appendix A — Interpretations or Deviations From FMVSS 106

F. Appendix B — Test Equipment List and Calibration Information

G. Appendix C — Photographs